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| **ECOLOGY**  **ΕΡΓΑΣΙΑ 1**  **26/03/2018**  **ΕΥΘΥΜΙΑΔΟΥ ΕΥΘΥΜΙΑ (4011)** |

Περιεχόμενα

[1. Levels, scope, and scale of organization 2](#_Toc509871260)

[Hierarchy 2](#_Toc509871261)

[Biodiversity 3](#_Toc509871262)

[2. Human ecology 4](#_Toc509871263)

[Restoration and management 4](#_Toc509871264)

[3. Relation to the environment 6](#_Toc509871265)

[Disturbance and resilience 6](#_Toc509871266)

[4. Ecological complexity 8](#_Toc509871267)

[Holism 8](#_Toc509871268)

[5. History 10](#_Toc509871269)

[Early beginnings 10](#_Toc509871270)

[Since 1900 11](#_Toc509871271)

[Η οικογένειά μου 13](#_Toc509871272)

# Levels, scope, and scale of organization

The scope of ecology contains a wide array of interacting levels of organization spanning micro-level (e.g., [cells](https://en.wikipedia.org/wiki/Cell_(biology))) to a planetary scale (e.g., [biosphere](https://en.wikipedia.org/wiki/Earth%27s_spheres)) [phenomena](https://en.wikipedia.org/wiki/Phenomena). Ecosystems, for example, contain abiotic [resources](https://en.wikipedia.org/wiki/Resource_(biology)) and interacting life forms (i.e., individual organisms that aggregate into [populations](https://en.wikipedia.org/wiki/Population) which aggregate into distinct ecological communities). Ecosystems are dynamic, they do not always follow a linear successional path, but they are always changing, sometimes rapidly and sometimes so slowly that it can take thousands of years for ecological processes to bring about certain [successional stages](https://en.wikipedia.org/wiki/Ecological_succession) of a forest. An ecosystem's area can vary greatly, from tiny to vast. A single tree is of little consequence to the classification of a forest ecosystem, but critically relevant to organisms living in and on it. Several generations of an [aphid](https://en.wikipedia.org/wiki/Aphid) population can exist over the lifespan of a single leaf. Each of those aphids, in turn, support diverse [bacterial](https://en.wikipedia.org/wiki/Bacteria) communities. The nature of connections in ecological communities cannot be explained by knowing the details of each species in isolation, because the emergent pattern is neither revealed nor predicted until the ecosystem is studied as an integrated whole. Some ecological principles, however, do exhibit collective properties where the sum of the components explain the properties of the whole, such as birth rates of a population being equal to the sum of individual births over a designated time frame.

### Hierarchy

The scale of ecological dynamics can operate like a closed system, such as aphids migrating on a single tree, while at the same time remain open with regard to broader scale influences, such as atmosphere or climate. Hence, ecologists classify [ecosystems](https://en.wikipedia.org/wiki/Ecosystems)hierarchically by analyzing data collected from finer scale units, such as vegetation associations, climate, and soil types, and integrate this information to identify emergent patterns of uniform organization and processes that operate on local to regional, [landscape](https://en.wikipedia.org/wiki/Landscape), and chronological scales.

To structure the study of ecology into a conceptually manageable framework, the biological world is organized into a [nested hierarchy](https://en.wikipedia.org/wiki/Biological_classification), ranging in scale from [genes](https://en.wikipedia.org/wiki/Gene), to [cells](https://en.wikipedia.org/wiki/Cell_(biology)), to [tissues](https://en.wikipedia.org/wiki/Tissue_(biology)), to [organs](https://en.wikipedia.org/wiki/Organ_(anatomy)), to [organisms](https://en.wikipedia.org/wiki/Organism), to [species](https://en.wikipedia.org/wiki/Species), to [populations](https://en.wikipedia.org/wiki/Population_ecology), to [communities](https://en.wikipedia.org/wiki/Community_(ecology)), to [ecosystems](https://en.wikipedia.org/wiki/Ecosystem), to [biomes](https://en.wikipedia.org/wiki/Biome), and up to the level of the [biosphere](https://en.wikipedia.org/wiki/Biosphere). This framework forms a [panarchy](https://en.wikipedia.org/wiki/Panarchy) and exhibits [non-linear](https://en.wikipedia.org/wiki/Non-linear)behaviors; this means that "effect and cause are disproportionate, so that small changes to critical variables, such as the number of [nitrogen fixers](https://en.wikipedia.org/wiki/Nitrogen_fixation), can lead to disproportionate, perhaps irreversible, changes in the system properties."

### Biodiversity

Biodiversity (an abbreviation of "biological diversity") describes the diversity of life from genes to ecosystems and spans every level of biological organization. The term has several interpretations, and there are many ways to index, measure, characterize, and represent its complex organization. Biodiversity includes [species diversity](https://en.wikipedia.org/wiki/Species_diversity), [ecosystem diversity](https://en.wikipedia.org/wiki/Ecosystem_diversity), and [genetic diversity](https://en.wikipedia.org/wiki/Genetic_diversity) and scientists are interested in the way that this diversity affects the complex ecological processes operating at and among these respective levels. Biodiversity plays an important role in [ecosystem services](https://en.wikipedia.org/wiki/Ecosystem_service) which by definition maintain and improve human quality of life. Conservation priorities and management techniques require different approaches and considerations to address the full ecological scope of biodiversity. [Natural capital](https://en.wikipedia.org/wiki/Natural_capital) that supports populations is critical for maintaining [ecosystem services](https://en.wikipedia.org/wiki/Ecosystem_services)and species [migration](https://en.wikipedia.org/wiki/Animal_migration) (e.g., riverine fish runs and avian insect control) has been implicated as one mechanism by which those service losses are experienced. An understanding of biodiversity has practical applications for species and ecosystem-level conservation planners as they make management recommendations to consulting firms, governments, and industry.

# Human ecology

Ecology is as much a biological science as it is a human science. Human ecology is an [interdisciplinary](https://en.wikipedia.org/wiki/Interdisciplinary) investigation into the ecology of our species. "Human ecology may be defined: (1) from a bioecological standpoint as the study of man as the ecological dominant in plant and animal communities and systems; (2) from a bioecological standpoint as simply another animal affecting and being affected by his physical environment; and (3) as a human being, somehow different from animal life in general, interacting with physical and modified environments in a distinctive and creative way. A truly interdisciplinary human ecology will most likely address itself to all three. The term was formally introduced in 1921, but many sociologists, geographers, psychologists, and other disciplines were interested in human relations to natural systems centuries prior, especially in the late 19th century.

The ecological complexities human beings are facing through the technological transformation of the planetary biome has brought on the [Anthropocene](https://en.wikipedia.org/wiki/Anthropocene). The unique set of circumstances has generated the need for a new unifying science called [coupled human and natural systems](https://en.wikipedia.org/wiki/Coupled_human_and_natural_systems) that builds upon, but moves beyond the field of human ecology. Ecosystems tie into human societies through the critical and all encompassing life-supporting functions they sustain. In recognition of these functions and the incapability of traditional economic valuation methods to see the value in ecosystems, there has been a surge of interest in [social](https://en.wikipedia.org/wiki/Social_capital)-[natural capital](https://en.wikipedia.org/wiki/Natural_capital), which provides the means to put a value on the stock and use of information and materials stemming from [ecosystem goods and services](https://en.wikipedia.org/wiki/Ecosystem_services). Ecosystems produce, regulate, maintain, and supply services of critical necessity and beneficial to human health (cognitive and physiological), economies, and they even provide an information or reference function as a living library giving opportunities for science and cognitive development in children engaged in the complexity of the natural world. Ecosystems relate importantly to human ecology as they are the ultimate base foundation of global economics as every commodity, and the capacity for exchange ultimately stems from the ecosystems on Earth.

### Restoration and management

Ecology is an employed science of restoration, repairing disturbed sites through human intervention, in natural resource management, and in [environmental impact assessments](https://en.wikipedia.org/wiki/Environmental_impact_assessment). Edward O. Wilson predicted in 1992 that the 21st century "will be the era of restoration in ecology" Ecological science has boomed in the industrial investment of restoring ecosystems and their processes in abandoned sites after disturbance. Natural resource managers, in [forestry](https://en.wikipedia.org/wiki/Silviculture), for example, employ ecologists to develop, adapt, and implement [ecosystem based methods](https://en.wikipedia.org/wiki/Ecosystem_management) into the planning, operation, and restoration phases of land-use. Ecological science is used in the methods of sustainable harvesting, disease, and fire outbreak management, in fisheries stock management, for integrating land-use with protected areas and communities, and conservation in complex geo-political landscapes.

# Relation to the environment

The environment of ecosystems includes both physical parameters and biotic attributes. It is dynamically interlinked, and contains [resources](https://en.wikipedia.org/wiki/Resource_(biology)) for organisms at any time throughout their life cycle. Like ecology, the term environment has different conceptual meanings and overlaps with the concept of nature. Environment "includes the physical world, the social world of human relations and the built world of human creation. The physical environment is external to the level of biological organization under investigation, including [abiotic](https://en.wikipedia.org/wiki/Abiotic) factors such as temperature, radiation, light, chemistry, [climate](https://en.wikipedia.org/wiki/Climate) and geology. The biotic environment includes genes, cells, organisms, members of the same species ([conspecifics](https://en.wikipedia.org/wiki/Conspecific)) and other species that share a habitat.

The distinction between external and internal environments, however, is an abstraction parsing life and environment into units or facts that are inseparable in reality. There is an interpenetration of cause and effect between the environment and life. The laws of [thermodynamics](https://en.wikipedia.org/wiki/Thermodynamics), for example, apply to ecology by means of its physical state. With an understanding of metabolic and thermodynamic principles, a complete accounting of energy and material flow can be traced through an ecosystem. In this way, the environmental and ecological relations are studied through reference to conceptually manageable and isolated [material](https://en.wikipedia.org/wiki/Materialism) parts. After the effective environmental components are understood through reference to their causes; however, they conceptually link back together as an integrated whole, or *holocoenotic* system as it was once called. This is known as the [dialectical](https://en.wikipedia.org/wiki/Dialectical) approach to ecology. The dialectical approach examines the parts, but integrates the organism and the environment into a dynamic whole (or [umwelt](https://en.wikipedia.org/wiki/Umwelt)). Change in one ecological or environmental factor can concurrently affect the dynamic state of an entire ecosystem.

### Disturbance and resilience

Ecosystems are regularly confronted with natural environmental variations and disturbances over time and geographic space. A disturbance is any process that removes biomass from a community, such as a fire, flood, drought, or predation.Disturbances occur over vastly different ranges in terms of magnitudes as well as distances and time periods,and are both the cause and product of natural fluctuations in death rates, species assemblages, and biomass densities within an ecological community. These disturbances create places of renewal where new directions emerge from the patchwork of natural experimentation and opportunity. Ecological resilience is a cornerstone theory in ecosystem management. Biodiversity fuels the resilience of ecosystems acting as a kind of regenerative insurance.

Complex Table(less accessible)

**Class Schedule**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **LESSON** | **TOPIC** | **ASSIGNMENT** | **Points** | **DUE** |
| 1 | What is Distance Learning? | Wiki#1 | 10 | March 10 |
| Presentation | 20 |  |
| 2 | History & Theories | Brief Paper | 20 | March 24 |
| Spring Break | | | | |
| 3 | Distance Learners | Discussion #1 | 10 | April 7 |
| Group Project | 50 | April 14 |
| 4 | Media Selection | Blog #1 | 10 | April 21 |

# lifecycle_apple.gifEcological complexity

Complexity is understood as a large computational effort needed to piece together numerous interacting parts exceeding the iterative memory capacity of the human mind. Global patterns of biological diversity are complex. This [biocomplexity](https://en.wikipedia.org/wiki/Biocomplexity) stems from the interplay among ecological processes that operate and influence patterns at different scales that grade into each other, such as transitional areas or [ecotones](https://en.wikipedia.org/wiki/Ecotones) spanning landscapes. Complexity stems from the interplay among levels of biological organization as energy, and matter is integrated into larger units that superimpose onto the smaller parts. "What were wholes on one level become parts on a higher one."Small scale patterns do not necessarily explain large scale phenomena, otherwise captured in the expression (coined by Aristotle) 'the sum is greater than the parts'.

"Complexity in ecology is of at least six distinct types: spatial, temporal, structural, process, behavioral, and geometric." From these principles, ecologists have identified [emergent](https://en.wikipedia.org/wiki/Emergence) and [self-organizing](https://en.wikipedia.org/wiki/Self-organization#Self-organization_in_biology) phenomena that operate at different environmental scales of influence, ranging from molecular to planetary, and these require different explanations at each integrative level. Ecological complexity relates to the dynamic resilience of ecosystems that transition to multiple shifting steady-states directed by random fluctuations of history. Long-term ecological studies provide important track records to better understand the complexity and resilience of ecosystems over longer temporal and broader spatial scales. These studies are managed by the International Long Term Ecological Network (LTER). The longest experiment in existence is the [Park Grass Experiment](https://en.wikipedia.org/wiki/Park_Grass_Experiment), which was initiated in 1856.Another example is the [Hubbard Brook study](https://en.wikipedia.org/wiki/Hubbard_Brook_Experimental_Forest), which has been in operation since 1960.

### Holism

Holism remains a critical part of the theoretical foundation in contemporary ecological studies. Holism addresses the [**biological organization**](https://en.wikipedia.org/wiki/Biological_organisation) of life that [**self-organizes**](https://en.wikipedia.org/wiki/Systems_biology) into layers of emergent whole systems that function according to non-reducible properties. This means that higher order patterns of a whole functional system, such as an [**ecosystem**](https://en.wikipedia.org/wiki/Ecosystem), cannot be predicted or understood by a simple summation of the parts."New properties emerge because the components interact, not because the basic nature of the components is changed.

Ecological studies are necessarily holistic as opposed to [reductionistic](https://en.wikipedia.org/wiki/Reductionistic). Holism has three scientific meanings or uses that identify with ecology: 1) the mechanistic complexity of ecosystems, 2) the practical description of patterns in quantitative reductionist terms where correlations may be identified but nothing is understood about the causal relations without reference to the whole system, which leads to 3) a [metaphysical](https://en.wikipedia.org/wiki/Metaphysics) hierarchy whereby the causal relations of larger systems are understood without reference to the smaller parts. Scientific holism differs from [mysticism](https://en.wikipedia.org/wiki/Mysticism) that has appropriated the same term. An example of metaphysical holism is identified in the trend of increased exterior thickness in shells of different species. The reason for a thickness increase can be understood through reference to principles of natural selection via predation without need to reference or understand the [biomolecular](https://en.wikipedia.org/wiki/Biomolecular) properties of the exterior shells.

# History

### Early beginnings

Ecology has a complex origin, due in large part to its interdisciplinary nature. Ancient Greek philosophers such as [Hippocrates](https://en.wikipedia.org/wiki/Hippocrates) and [Aristotle](https://en.wikipedia.org/wiki/Aristotle) were among the first to record observations on natural history. However, they viewed life in terms of [essentialism](https://en.wikipedia.org/wiki/Essentialism), where species were conceptualized as static unchanging things while varieties were seen as aberrations of an [idealized type](https://en.wikipedia.org/wiki/Idealism). This contrasts against the modern understanding of [ecological theory](https://en.wikipedia.org/wiki/Theoretical_ecology) where varieties are viewed as the real phenomena of interest and having a role in the origins of adaptations by means of [natural selection](https://en.wikipedia.org/wiki/Natural_selection). Early conceptions of ecology, such as a balance and regulation in nature can be traced to [Herodotus](https://en.wikipedia.org/wiki/Herodotus) (died *c*. 425 BC), who described one of the earliest accounts of [mutualism](https://en.wikipedia.org/wiki/Mutualism_(biology)) in his observation of "natural dentistry". Basking [Nile crocodiles](https://en.wikipedia.org/wiki/Nile_crocodile), he noted, would open their mouths to give [sandpipers](https://en.wikipedia.org/wiki/Sandpiper) safe access to pluck [leeches](https://en.wikipedia.org/wiki/Leech)out, giving nutrition to the sandpiper and oral hygiene for the crocodile. Aristotle was an early influence on the philosophical development of ecology. He and his student [Theophrastus](https://en.wikipedia.org/wiki/Theophrastus) made extensive observations on plant and animal migrations, biogeography, physiology, and on their behaviour, giving an early analogue to the modern concept of an ecological niche. Ecological concepts such as food chains, population regulation, and productivity were first developed in the 1700s, through the published works of microscopist [Antoni van Leeuwenhoek](https://en.wikipedia.org/wiki/Antoni_van_Leeuwenhoek) (1632–1723) and botanist [Richard Bradley](https://en.wikipedia.org/wiki/Richard_Bradley_(botanist)) (1688?–1732).Biogeographer [Alexander von Humboldt](https://en.wikipedia.org/wiki/Alexander_von_Humboldt) (1769–1859) was an early pioneer in ecological thinking and was among the first to recognize ecological gradients, where species are replaced or altered in form along [environmental gradients](https://en.wikipedia.org/wiki/Environmental_gradient), such as a [cline](https://en.wikipedia.org/wiki/Cline_(biology)) forming along a rise in elevation. Humboldt drew inspiration from [Isaac Newton](https://en.wikipedia.org/wiki/Isaac_Newton) as he developed a form of "terrestrial physics". In Newtonian fashion, he brought a scientific exactitude for measurement into natural history and even alluded to concepts that are the foundation of a modern ecological law on species-to-area relationships.Natural historians, such as Humboldt, [James Hutton](https://en.wikipedia.org/wiki/James_Hutton), and [Jean-Baptiste Lamarck](https://en.wikipedia.org/wiki/Jean-Baptiste_Lamarck) (among others) laid the foundations of the modern ecological sciences. The term "ecology" ([German](https://en.wikipedia.org/wiki/German_language): *Oekologie, Ökologie*) is of a more recent origin and was first coined by the German biologist [Ernst Haeckel](https://en.wikipedia.org/wiki/Ernst_Haeckel) in his book *Generelle Morphologie der Organismen* (1866). Haeckel was a zoologist, artist, writer, and later in life a professor of comparative anatomy.

Opinions differ on who was the founder of modern ecological theory. Some mark Haeckel's definition as the beginning; others say it was [Eugenius Warming](https://en.wikipedia.org/wiki/Eugenius_Warming) with the writing of [Oecology of Plants: An Introduction to the Study of Plant Communities](https://en.wikipedia.org/wiki/Plantesamfund) (1895),or [Carl Linnaeus](https://en.wikipedia.org/wiki/Carl_Linnaeus)' principles on the economy of nature that matured in the early 18th century. Linnaeus founded an early branch of ecology that he called the economy of nature.His works influenced Charles Darwin, who adopted Linnaeus' phrase on the *economy or polity of nature* in [*The Origin of Species*](https://en.wikipedia.org/wiki/The_Origin_of_Species). Linnaeus was the first to frame the [balance of nature](https://en.wikipedia.org/wiki/Balance_of_nature) as a testable hypothesis. Haeckel, who admired Darwin's work, defined ecology in reference to the economy of nature, which has led some to question whether ecology and the economy of nature are synonymous.

### Since 1900

Modern ecology is a young science that first attracted substantial scientific attention toward the end of the 19th century (around the same time that evolutionary studies were gaining scientific interest). The scientist [Ellen Swallow Richards](https://en.wikipedia.org/wiki/Ellen_Swallow_Richards) may have first introduced the term "[oekology](https://en.wikipedia.org/wiki/Oekology)" (which eventually morphed into [home economics](https://en.wikipedia.org/wiki/Home_economics)) in the U.S. as early 1892.

In the early 20th century, ecology transitioned from a more [descriptive form](https://en.wikipedia.org/wiki/Metaphysics) of [natural history](https://en.wikipedia.org/wiki/Natural_history) to a more [analytical form](https://en.wikipedia.org/wiki/Scientific_method) of *scientific natural history*. [Frederic Clements](https://en.wikipedia.org/wiki/Frederic_Clements) published the first American ecology book in 1905, presenting the idea of plant communities as a [superorganism](https://en.wikipedia.org/wiki/Superorganism). This publication launched a debate between ecological holism and individualism that lasted until the 1970s. Clements' superorganism concept proposed that ecosystems progress through regular and determined stages of [seral development](https://en.wikipedia.org/wiki/Seral_development) that are analogous to the developmental stages of an organism. The Clementsian paradigm was challenged by [Henry Gleason](https://en.wikipedia.org/wiki/Henry_Gleason), who stated that ecological communities develop from the unique and coincidental association of individual organisms. This perceptual shift placed the focus back onto the life histories of individual organisms and how this relates to the development of community associations.

The Clementsian superorganism theory was an overextended application of an [idealistic form](https://en.wikipedia.org/wiki/Idealism) of holism. The term "holism" was coined in 1926 by [Jan Christiaan Smuts](https://en.wikipedia.org/wiki/Jan_Christiaan_Smuts), a South African general and polarizing historical figure who was inspired by Clements' superorganism concept. Around the same time, [Charles Elton](https://en.wikipedia.org/wiki/Charles_Sutherland_Elton) pioneered the concept of food chains in his classical book *Animal Ecology*. Eltondefined ecological relations using concepts of food chains, food cycles, and food size, and described numerical relations among different functional groups and their relative abundance. Elton's 'food cycle' was replaced by 'food web' in a subsequent ecological text.[Alfred J. Lotka](https://en.wikipedia.org/wiki/Alfred_J._Lotka) brought in many theoretical concepts applying thermodynamic principles to ecology.

In 1942, [Raymond Lindeman](https://en.wikipedia.org/wiki/Raymond_Lindeman) wrote a landmark paper on the [trophic dynamics](https://en.wikipedia.org/wiki/Trophic_dynamics#Trophic_dynamics) of ecology, which was published posthumously after initially being rejected for its theoretical emphasis. Trophic dynamics became the foundation for much of the work to follow on energy and material flow through ecosystems. [Robert MacArthur](https://en.wikipedia.org/wiki/Robert_MacArthur) advanced mathematical theory, predictions, and tests in ecology in the 1950s, which inspired a resurgent school of theoretical mathematical ecologists Ecology also has developed through contributions from other nations, including Russia's [Vladimir Vernadsky](https://en.wikipedia.org/wiki/Vladimir_Vernadsky) and his founding of the biosphere concept in the 1920s and Japan's [Kinji Imanishi](https://en.wikipedia.org/wiki/Kinji_Imanishi) and his concepts of harmony in nature and habitat segregation in the 1950s. Scientific recognition of contributions to ecology from non-English-speaking cultures is hampered by language and translation barriers.

# Η οικογένειά μου